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THE AMERICAN
METEOROLOGICAL JOURNAL

VOL. VIII. ANN ARBOR, MICH., FEBRUARY, 1892. No 10.

ORIGINAL ARTICLES.

THE INTERNATIONAL METEOROLOGICAL CONFERENCE AT MUNICH.

BY A. LAWRENCE ROTCH.

The conference of meteorologists which was announced in THE JOURNAL, was held in Munich from August 26 to September 2, 1891. It was brought about by Messrs. Scott and Wild, who were requested by the International Meteorological Committee, before it was dissolved at the meeting in Zurich, in 1888, to undertake the duty of organizing, at a suitable date, a meeting of the representatives of the various meteorological services. It was decided that, at least so far as Europe was concerned, only the heads of meteorological services were to be invited and that these were not to be delegated by their respective governments, so that the meeting was not to be considered as official. The programme was made up from questions which had not been definitely decided by the International Committee, or of questions which had been sent in response to the circular, and was printed in English, French and German.

The meeting was opened in the Royal Technical High School of Bavaria, on the morning of August 26. Prof. Wild, as president of the International Meteorological Committee, read a report drawn up by Mr. Scott, the secretary, stating the nature and aims of the Conference. The roll of invited persons being called, it appeared that the following were present:

EUROPE.

France.—M. E. Mascart, director of the Central Meteorological Bureau in Paris. M. L. Teisserenc de Bort, secretary of the French Meteorological Society.

Great Britain.—R. H. Scott, Esq., secretary of the London Meteorological Office and representing also the Royal Meteorological Society and the Government Astronomer of Adelaide, Australia.

Germany.—Prof. Dr. Neumayer, director of the Deutsche Seewarte. Dr. W. von Bezold, director of the Royal Prussian Meteorological Institute. Dr. Eschenhagen, chief of the magnetic department of the Prussian Meteorological Institute. Dr. P. Schreiber, director of the Royal Saxon Meteorological Institute. Dr. C. Lang, director of the Royal Bavarian Meteorological Central Station. Dr. Erk, of the Bavarian Central Station. Prof. Dr. Mack, director of the Royal Wurtemberg Meteorological Central Station. Dr. Schultheiss, assistant at the Central Office for Meteorology and Hydrography of Baden. Dr. Hergesell, chief of the Meteorological System of Alsace-Lorraine.

Russia.—Prof. Dr. H. Wild, director of the Central Physical Observatory in St. Petersburg. Prof. Kwietniewski, chief of the private Polish Meteorological Service. Dr. A. von Oettingen, chief of the Pluviometric Service of Livonia.

Finland.—Dr. E. Biese, director of the Magnetic and Meteorological Observatory at Helsingfors.

Norway.—Prof. H. Mohn, director of the Norwegian Meteorological Institute at Christiania.

Sweden.—Prof. Dr. H. H. Hildebrandsson, director of the Meteorological Observatory at Upsala.

Denmark.—M. A. Paulsen, director of the Danish Meteorological Institute at Copenhagen.

Hungary.—Dr. N. von Konkoly, director of the Central Meteorological Bureau in Buda-Pesth.

Roumania.—M. S. Hepites, director of the Roumanian Meteorological Service, Bucharest.

Netherlands.—M. M. Snellen, director of the Dutch Meteorological Institute at Utrecht.

Switzerland.—Dr. R. Billwiller, director of the Swiss Central Meteorological Bureau at Zurich.

Spain.—M. A. Arcimis, director of the Central Meteorological Institute at Madrid.

Bulgaria.—Prof. S. Watzoff, of Sophia.

AUSTRALIA.

Queensland.—C. L. Wragge, Esq., Government Meteorologist, Brisbane.

AMERICA.

United States.—Prof. M. W. Harrington, chief of the United States Weather Bureau. Prof. C. Abbe, of the United States Weather Bureau. Mr. A. L. Rotch, director of the Blue Hill Observatory, representing also the New England Meteorological Society.

South America.—Capt. A. P. Pinheiro, Meteorological Department of the Navy, Brazil.

Prof. Dr. J. Hann, the director of the Austrian Centra Bureau for Meteorology and Terrestrial Magnetism, and Gen. A. W. Greely, Chief Signal Officer, U. S. A., arrived on the second day. Dr. Singer, of Munich, and Mr. Clayton, of the Blue Hill Observatory, were also present as guests at the later meetings.

Messrs. Wild and Scott proposed the following methods of procedure: The Conference is to select one president, two vice-presidents, and three secretaries respectively conversant with German, French and English, and it shall be their duty to see to the preparation of the reports of the meetings in the three languages. (Three under-secretaries, not members of the Conference, were provided by Dr. Lang.) The language of the Conference is to be German, with the restriction that the reports are to be drawn up in the three languages, if requested, and the three-fold protocol is to be laid before the Conference at its next meeting, if possible in a printed form. Any member submitting a proposition, resolution or communication must draw it up in the three languages. All questions, except those relating to magnetism, are to be considered in full meeting, but for each class of questions the Conference shall appoint a reporter to prepare the subject for discussion. These by-laws were adopted and the reporters were nominated on the principle that a member proposing a question should himself report on it.

The Conference elected Dr. Lang, president; Professors Harrington and Mascart, vice-presidents; Messrs. Erk, Scott and Teisserenc de Bort, secretaries. The warmest thanks were tendered to the International Meteorological Committee, and especially to Messrs. Wild and Scott for the great trouble they had taken to arrange the Conference, and a suitable resolution

of sympathy was sent to the family of the late Prof. Buys-Ballot.

At the second meeting of the Conference, the consideration of the programme was commenced.

I. INSTRUMENTS AND METHODS OF OBSERVATION.

a. Standard Instruments and Comparisons thereof.—Prof. Wild in his submitted report said: The successive congresses have stated it to be desirable that barometer readings should be given to an accuracy of 0.1 mm. and temperatures to that of 0.1° C., and it is therefore desirable that these magnitudes should be comparable between different countries up to these limits. This is not the case, comparisons which have been made having shown that the so-called standard barometers in different countries differ *inter se* more than several hundredths of a millimeter. Mercurial thermometers, well verified, differ within about 0.1° C. between 0° and 50° C., but below 0°, and especially at –30° to –40° C., where we have to change to the spirit thermometer, differences of more than a whole degree may easily occur. Hence comparisons of standard instruments are still desirable, but on account of the expense, it appears to me that Dr. Hann's proposal to restrict the comparison between the standard instruments of contiguous countries is the best, and I would add that the results of such comparisons should always be published. After some remarks, the Conference adopted unanimously the following resolution: "The Conference is of opinion that the barometers of contiguous countries should be compared and the results of these comparisons published. It is also desirable that comparisons should, as soon as possible, be made with the barometer of the International Bureau of Weights and Measures."

Dr. Neumayer remarked that in accordance with the resolution of the Maritime-Meteorological Conference at London in 1874, officers on board ships should make comparisons of barometers in foreign countries, and made the following proposal, which was unanimously accepted: "The comparisons of barometers obtained by marine meteorological observers are to be published together with the standard readings of the baromters of the respective systems from time to time." Gen. Greely said that formerly such comparisons had been made by the Signal Office, but that some years ago this duty was transferred to the Hydrographic Office. As the Hydrographer was not a

a member of the Conference, the representatives of the United States could not make any binding engagements for that officer.

On the comparison of thermometers, Prof. Wild reported as follows: "As the International Bureau of Weights and Measures is now able to compare standard spirit thermometers with the air thermometer down to –70° C. and to give their corrections, it is possible for each country to obtain such thermometers and therefore to refer temperatures in meteorology to the air thermometer, a most important point for low temperatures." After some remarks, the Conference adopted unanimously the following resolution made conjointly by MM. Mascart and Wild: "The Conference is of opinion that temperatures should be referred to the air thermometer. This definition is especially necessary for temperatures below 0° C. The Conference therefore expresses its sincere thanks to the International Bureau of Weights and Measures for the information that it is henceforth in a position to supply standard thermometers to the different institutes."

MM. Mohn and Mascart wished a definite epoch to be fixed for the introduction of the new measure, and the resolution was adopted in the following form: "All meteorologists are recommended to introduce the practice of referring temperatures to the air thermometer as soon as possible, but the change should be made at the latest with the year 1901, and it should be stated in the publications whether the temperatures have been reduced to those of the air thermometer."

b. Temperature of the Air.—Mr. Rotch submitted the question: Is it not to be recommended that Maximum and Minimum Thermometers should be generally read and set at an Hour when the Temperature is as near Normal as possible, for example, between 6 P. M. and 9 P. M.? Messrs. Billwiller and Rotch reported on it, and after considerable discussion, in which practical difficulties of carrying out the plan were stated, the Conference adopted the following resolution: "The Conference states that it is of paramount importance to give in every case the hour at which the maximum and minimum thermometers are read and set."

Concerning the question of Radiation, the Conference was of opinion "that although great progress had been made in the direction of actinometric determinations, no method of observation has yet been proposed which could be recommended for general adoption."

c. Humidity.—Prof. Wild made the following proposal, which was unanimously adopted: "The Conference is of opinion that the resolution of the Congress of Rome on the subject of hygrometric observations, recommending the employment, as far as may be possible, of a regular arrangement for ventilation in the determination of the humidity of the air by means of the dry and wet bulb thermometers should not at the present time be modified."

d. Precipitation. Regarding the definition of a Rainy Day there was much discussion of the minimum amount required. The following modified resolution of Prof. Wild was finally adopted: "It is proposed to give in the summaries the number of days on which 0.1 mm., and, if possible, those also on which 1 mm is collected, independently of other limits which may have been introduced in individual systems.

On the question of Dew, the proposition of M. Colin, of Mauritius, regarding its separate measurement, was not adopted.

Respecting Stricter Methods of Noting and Discussing Precipitation, Dr. Neumayer submitted the following note without proposing any action on the part of the Conference: "There can be no doubt that in almost every country an increase in the number of stations of the first order is desirable, but the location of any such station should be selected after a careful examination into the climatological and meteorological conditions which it represents, while the conditions of opportunity should be only a secondary consideration. If stations of the first order could be located over each country strictly on the principles above stated, a demand in meteorology which has been long and seriously felt would be satisfied, viz., the arrangement of the stations of the second order in two groups affected by the same local circumstances. In this way rainfall stations might easily be gathered into groups, for which a typical first-order station might be selected to represent the quantity, intensity and actual duration of the falls and thereby render it possible in many cases, if not all, to obtain very useful information. It should, therefore, be the earnest endeavor of meteorologists to aim at such a strictly scientific distribution of meteorological and climatological stations as has been indicated above."

Regarding the Hour of Measurement of Rain, the proposal of Prof. Wild that the precipitation be measured at the hour of the last daily observation instead of at the hour of the first

daily observation, was deemed impracticable by the Conference and was accordingly withdrawn by the author.

"With respect to the Altitude of Rain Gauges above the Ground, which had not been definitely fixed by the decisions of the Congress of Rome, the present Conference is of opinion that in view of the wide differences presented by climatological conditions over the globe, it is not possible to lay down any uniform height for rain-gauges, and it therefore adopts the resolution of the Congress of Rome, with this modification that rain-gauges should never be placed upon a sloping roof, but that they should be sufficiently elevated to be out of the influence of drifting snow and of the splashing of drops from the ground, while they must not be sheltered by trees or other neighboring objects."

As to the Measurement of Snow, on Mr. Scott's proposal, it was requested that information resulting from practical experience, be sent in writing to the Secretaries. It was decided to change the English equivalent of the term "Schneetreiben" or "chasse de neige," from "snow drift" to "drifting snow."

e. Duration of Sunshine and Amount, etc., of Cloud.—Mr. Scott, in reporting on the Registration of Sunshine, said that, as far as he knew, there were only three sunshine recorders in general use, the burning Campbell-Stokes instrument and the two photographic instruments of Jordan and Maurer. He thought an increase in the number of stations and an improvement in the mode of managing all classes of instruments was desirable. On the proposal of Prof. Wild it was unanimously decided: "That the Conference expresses the wish that the registration of sunshine should be extended as much as possible."

The Adoption of a Definite Zenithal Zone for the Estimation of the Amount of Cloud was reported upon by Mr. Rotch, who cited comparisons of the data obtained at the Blue Hill Observatory from a Campbell-Stokes sunshine recorder, Pickering's pole-star recorder and eye observations, from which it appeared that the real cloudiness is better obtained if the zone of observation is restricted to say 45° from the zenith, than if the apparent cloudiness of the whole sky is considered. Prof. Wild submitted the results of researches which had been made at Pawlowsk. A discussion followed in which the other United States members opposed the limitation to the zenithal zone for general use. Finally, on the proposal of Profs. Wild and Abbe,

the following resolution was adopted: "The Conference recommends that at several stations in each country comparative observations should be instituted of the amount of cloud for the whole sky with a clear horizon, and of zenithal zones of 45° and 60°."

One of the most important questions considered by the Conference was the Classification of Clouds and the Cloud Atlas, upon which Dr. Neumayer reported. He said: "No one can be more convinced than the authors of the Cloud-Atlas (edited by Drs. Neumayer, Köppen and Hildebrandsson, Hamburg, 1890) that there is room for improvement in it, and that in the course of time it will be improved. It cannot be doubted, however, that this Atlas is to be considered as a first step toward uniformity in this important matter, and supplies a long felt desideratum in our meteorological literature and in the instruction to observers. Far from making a proposal that the Cloud Atlas should be procured for each institution and supplied, as an addition to instructions, we only recommend that the principle should be recognized which lies at the bottom of the classification and nomenclature, and that this principle should be pursued in any smaller and cheaper reproduction. We think that we are not prepared to undergo any artistic criticims of the Atlas."

Notwithstanding the dissent of Messrs. Scott, Harrington and Schultheiss it was resolved: "That the Conference recommends the adoption of the cloud classification proposed by MM. Hildebrandsson and Abercromby."

The artistic representation of clouds was then discussed and photographs collected by Dr. Singer and others made by M. Garnier, of Paris, were exhibited. The following resolution was unanimously adopted: "The Cloud-Atlas in its present form is to be recognized as the first satisfactory attempt to obtain uniformity in the nomenclature of cloud observations. It is desirable to form a committee in order to obtain smaller and cheaper reproductions of cloud pictures without abandoning the use of color. The committee should consider the Cloud Atlas, as well as the other pictures submitted to the Conference."

The following committee with the right of co-option was appointed: MM. Hann, Hildebrandsson, Teisserenc de Bort and Rotch. Dr. Singer was subsequently asked to join the committee.

As to the Designation of the form of Clouds when the Sky is entirely Overcast, it was decided to abide by the resolution adopted at Paris, and to leave the entry blank.

Dr. Hildebrandsson reported on the Measurement of the Direction of Motion and the Height of Clouds and proposed that a committee should be formed of all the heads of institutions who had any special interest in the subject. (The names of about a dozen meteorologists who agreed to make such measurements in various parts of the world were subsequently obtained.) Dr. Hildebrandsson distributed a report on the results of the measurements which had been made at Upsala, and Mr. Rotch did the same for Blue Hill.* Mr. Scott promised to send an account of the work which was being done at the Kew Observatory in this direction.

f. Hydrometeors. As the Vienna Congress had not given any definition for halos and coronæ, a difference of usage has arisen owing in part to a faulty translation of these terms into other languages. Dr. Neumayer reported upon the subject that the definition given by Dr. Galle should be adopted. Mr. Rotch further called attention to the confusion which existed in the symbols for halo (Ring) and corona (Hof) in the English and German reports of the Vienna Congress. Accordingly, the following definitions were recognized as correct by the Conference:

"Halo = Ring, has a radius of $22° - 40°$.

"Corona = Hof, has a radius of $6° - 15°$."

Dr. von Oettingen expressed the wish that observations of Rainbows might be more carefully carried out, but Dr. Hildebrandsson thought that no great importance was to be attached to the appearance of the phenomenon.

Mr. Rotch cited two different conditions which gave rise to silver-thaw (Rauhfrost or Duft, givre) and glazed-frost (Glatteis, verglas). Dr. Hann proposed to take the outward form of the covering as characteristic of the phenomenon without attempting to trace its origin, and other gentlemen expressed the opinion that owing to the manifold changes and modifications exhibited by these phenomena it was not always possible to trace them back to their origin. Accordingly the Conference resolved unanimously that:

"Glazed-frost = Glatteis, is the smooth [clear] coating.

* Cloud Heights and Velocities at the Blue Hill Observatory, by H. H. Clayton, This JOURNAL, Vol. VIII., p. 108.

"Silver-thaw = Rauhfrost, is the rough [white] coating."

M. Watzoff proposed the introduction of a single symbol for the fact of the ground being covered with snow. After discussion the Conference decided: "If more than half of the country surrounding the station is under snow the symbol ⊡ (a square with a star inside) is to be employed."

Dr. von Bezold advocated a Distinction in the Symbols for Ground Fog and High Fog, and his proposition was finally adopted in this form: "The Conference recommends that a fog which does not exceed the height of a man should be classed as ground fog, and designated by the symbol ≡. At the same time it is clearly understood that a fog in a valley seen from a station on a higher level is not to be entered as 'ground fog.'"

g. Wind. The questions relating to this subject were: (1) Would it not be desirable to apply the corrections which are already known to the velocities given by the Robinson anemometer. (This question was proposed by M. Brito-Capello, of Lisbon, who sent a memorandum with it.) (2) The general adoption of a standard anemometer for the determination of the velocity of the wind. (3) The general adoption of a uniform height above the ground for anemometers. (4) The construction of a table for converting velocities, estimated by Beaufort's scale, into velocities in meters per second. Prof. Wild reported on the four questions and Mr. Scott informed the Conference that the results of the experiments which had been carried on by Mr. Dines had been published. Gen. Greely said that Prof. Marvin had determined the constants for the Robinson anemometers used in the United States, and had found that different instruments possessed different constants. The experiments were conducted partly by using a rotating apparatus and partly by wind velocities up to eighty miles per hour. These corrections were to be published in a tabular form and henceforth any person interested in the subject could obtain this table, together with the uncorrected figures, and might use his own discretion as to applying corrections. Prof. Harrington was of the opinion that it should not be expressly demanded that comparisons should be carried out by means of rotating apparatus, but that the employment of indirect methods should be admissible. Dr. Neumayer stated that for many years past detailed experiments on this subject had been in progress at the Deutsche Seewarte in Hamburg, and the results would be published shortly. He further remarked that although it is very important,

and in fact necessary, that the figures for wind velocity given by Robinson's anemometer should not be printed without giving the formula of reduction for each individual instrument, it is very desirable that instruments which have been tested and have had their constants determined at any central office should be compared at another central office with the instruments in use there. The Seewarte has in the course of years tested many such instruments and has sent them to other central offices. For this purpose Recknagel's anemometers are particularly serviceable. Dr. Hildebrandsson confirmed the statement. M. Teisserenc de Bort proposed that in the tables not only the correction should be given but also the date at which it had been determined. He was of the opinion, and Mr. Scott agreed with him, that the constants of anemometers were not invariable in the course of time. Moreover, the constants varied somewhat with the manner of verification. Prof. Wild remarked that the constants determined for instruments of the same dimensions agreed well together, and that it was chiefly the coëfficients of friction which differed between different instruments, and even these coëfficients did not alter much with time. Moreover, according to his experience, the constants determined by the various methods showed a very good accordance *inter se*.

The following resolutions were adopted:

1. "The Conference is of the opinion that it is desirable to give in the tables wind velocities in meters per second, the values to be obtained from the instrumental indications by means of a formula of reduction of which the constants have been determined either directly or indirectly."

2. "It appears to the Conference impossible to lay down general rules for anemometers, as to their erection or their height above the ground."

3. "The Conference expresses the wish that fresh investigations should be carried out to determine more correctly the relation between the grades of Beaufort's scale and velocities in meters per second."

h. Hours of Observation. Record of Time.—Mr. Rotch reported on the Substitution of Tenths of an Hour instead of Minutes in recording the Time of Occurrence. As the occurrences of meteorological phenomena are not generally recorded nearer than five minutes, if the time be recorded and printed in hours and tenths calculations would be simplified and economy in printing would result. This method has been

introduced in the publications of the Blue Hill Observatory. The opinion of the Conference being unfavorable to the proposition it was withdrawn by Mr. Rotch.

Dr. Neumayer reported upon Hours of Observation, that, although an agreement on this important subject is very desirable, it appears to be unattainable at present, as the number of conflicting interests in different systems which require to be adjusted is too formidable. It was therefore voted: "The Conference is of the opinion that the subject is of the highest importance but that it presents great difficulties, and that an international agreement on the subject is in the highest degree desirable."

On the Introduction of Universal or Zone Time, Prof. Wild reported that the introduction of zone time would be inimical to the needs of meteorology, as that science, as well as magnetism, had to be studied in connection with the local time for the station, and that it was only on special occasions that simultaneous or universal time came into use, while zone time could never be used.

As to the proposal to count the hours from 0 to 23 h., instead of from 0—11 A. M. and P. M., it would be an advantage to abandon the use of these letters, but still there was risk of frequent mistakes owing to this departure from the usages of ordinary life. It seemed, therefore, best to introduce the change in the publications only, and to insist on the designation of midnight as 0.

Prof. Wild's suggestion was thus confirmed: "The Conference is of the opinion that the introduction of zone time into meteorology would be very unfortunate.

"The introduction of the use of 0—23 h., commencing with midnight, is to be recommended, but only for the publications."

II. METHODS OF CALCULATION.

The wish expressed at the Roman Congress concerning the preparation of international tables for the reduction of pressure and temperature to sea-level, etc., has now been realized by the publication of the International Meteorological Tables with text in three languages (Paris, Gauthier—Villars et fils, 1890). The Conference took the opportunity of expressing its sincere thanks to MM. Mascart and Wild for the great labor they had devoted to carrying out this work to a successful issue.

Upon the Correction of Barometric Readings for Gravity,

Prof. Mohn reported as follows: As physicists, we all admit that barometer readings reduced simply to 32° F. and corrected for instrumental errors do not give the true measure of the atmospheric pressures, for they still require to be reduced to gravity at latitude 45°. The error due to the omission of this correction amounts to nearly two mm. at the Poles and at the Equator. At a single station the error from high to low readings may vary more than 0.1 mm. Between two stations in Norway in different latitudes and elevations and with different levels of the mercury, the error may attain 0.8 mm., which is, therefore, far greater than that of a single observation. The reduction can very easily be effected. The International Tables give the reduction to latitude 45° for different heights of the column and for different elevations. This may be combined with the instrumental and temperature corrections in a table giving the combined and complete reduction of the same form and extension as the ordinary table for the reduction to 32° alone.

Mr. Scott stated that on the recent charts of ocean barometric pressures, published by the Meteorological Office, the values had not been corrected for gravity, but the correction had been given in a table on the charts. The reason for this had been that sailors would not be able easily to compare their own readings with figures given on the charts, if these latter had many corrections applied to them. Prof. Harrington said that as yet this correction was not applied in the Weather Service. It had at one time been introduced by the Signal Service but the practice had been abandoned. He was afraid that great confusion would result from its introduction, and he was not in a position to give any binding promise that the practice would be adopted at any definite epoch. Dr. Neumayer reminded the Conference that the Polar Conference of 1884 had dealt with this question, and had declined to prescribe the adoption of this correction. He generally agreed with the practice of the Meteorological Office, and did not apply the correction in the marine charts of the Seewarte, but gave it in a side table. He, however, hoped that the gradual advance in the education of seamen would facilitate the gradual introduction of the suggested improvement. The date for the introduction of this correction was discussed and the following resolution was finally adopted: "It is recommended to all meteorologists to give the barometric readings reduced to the gravity of 45° as soon as possible, at the latest from the year 1901, and that always, in all

the tables and means of the publications, it be specially stated if the correction has been applied. At the head of such tables the values of the reduction to the gravity of 45° is to be given in such a manner that it may be immediately taken out with an accuracy of at least ± 0.1 mm. (0.004 inch)."

Concerning the Calculation of Daily Means of the Different Meteorological Elements, Prof. Mohn reported as follows: The method of calculation of the daily means of the different meteorological elements depends on several conditions such as climate, hours of observation, the possibility of finding the co-efficients from hourly observations at stations of the first order, etc. The Congress of Vienna proposed several rules for this purpose, with or without co-efficients. Since that time, the facilities for arriving at more accurate daily means have increased in almost all countries, and consequently better means than formerly are now obtainable. The following resolution, proposed by Prof. Mohn, was adopted: "The manner in which the daily means are calculated in the different meteorological systems should be described in the publications, with a statement of the methods and co-efficients employed."

On the Mean Deviation of Results from Normal Values, Mr. Rotch reported: The mean deviation of single observations from the normal is one method of determining the variability. These data are often neglected, but they possess practical and scientific importance. From the mean deviation, the probable error and the frequency of each degree of intensity of the phenomenon can be determined; also the constancy of the phenomenon and the relation between it and an assigned cause may be studied. Is it not to be recommended that at certain stations the mean deviation, as well as the average values of the phenomena, be obtained? The importance of this suggestion was at once admitted by the Conference, but the general feeling was that the determination of the mean deviation was a special scientific investigation which more properly fell to private students than to meteorological offices. The following resolution, proposed by Dr. Lang, was adopted: "It appears that the above calculations belong more properly to private investigators than to the official publications of central institutes."

Mr. Rotch also reported on the Publication of Frequency of Occurrence instead of the Mean Value of a Phenomenon, as follows: In phenomena, such as temperature and pressure, the arithmetical mean corresponds closely with the most frequent

value of such phenomena. If the average deviation from the mean is known, the frequency of occurrence of each degree of intensity can be determined. When, however, there is a limiting value of the phenomenon on one side, and zero is of frequent occurrence, as in the case of wind velocity and rainfall, or when th phenomenon does not increase by constant increments, as vapor tension, the arithmetical mean does not give the value of the most frequent occurrence, and it is impossible to obtain the probable error from the mean deviation. Would it not be better in these cases to determine the most frequent occurrence of these phenomena, as well as the mean value? After some discussion, in which Prof. Harrington said that although the method had been frequently used in America he did not think that any general introduction of the process should be prescribed, as it belonged properly to private investigations. Dr. Schreiber proposed the following resolution, which was unanimously adopted: "The Congress recommends that the calculations of mean values should be retained, but that in special cases the determination of frequency values should be introduced for all meteorological elements."

III. PUBLICATION OF OBSERVATIONS AND THEIR DISCUSSION.

Dr. Neumayer's report on the International Scheme for Publication was to the effect that all systems which have not yet adopted the scheme be invited to conform to the general demand for uniformity. The Conference approved of this suggestion. Prof. Harrington asked that a committee should be appointed to codify the decisions of the various congresses, conferences and committees. Mr. Scott offered to prepare such a *resumé* in the three languages, and this offer was gratefully accepted by the Conference.

In regard to Rules for the Publication of Observations from Distant Stations and from Travelers' Notes, Dr. Hann recommended his proposal made at the Zurich meeting of the International Committee, and stated that they had been adopted within the past few weeks by the International Geographic Congress at Berne. The following rules were unanimously adopted by the Conference:

"(1.) It should be stated what kind of instruments are used in the observations and besides their corrections, when those are known, details of the exposure should be given. The height of the barometer above sea-level is to be stated as accurately as

possible. (2.) Detailed information should be furnished concerning the methods used for the calculation of mean values, such as the hours of observation and the formulæ for reduction employed. It is further desirable, to give for the various hours of observation, the means for the temperature, humidity and atmospheric pressure, in order to facilitate the reduction to true means, which may be undertaken later. (3.) In the publication of the means for many years, it is very desirable to give the means for periods of five years (lustra), and these periods should agree with those recommended by the Vienna Congress, namely, commenced with the first year of each pentade, 1881–85, 1886–90, etc."

The question of the Publication of Details of the Topographical Position and Equipment of Meteorological Stations was introduced by Prof. Wild. After a discussion whether this should be extended to rainfall stations, the Conference resolved: "In the introduction to the publication of meteorological data more details should be given about the instruments used, their corrections and installations, and also as to the situation of stations of the first and second order, to afford means of judging of the relative value of the results."

The question of Baron von Heerdt, of Holland, as to whether it was desirable and possible to adopt a Uniform Method of Publication in Maritime Meteorology was discussed by MM. Neumayer, Scott and Snellen, and the Conference resolved: "That owing to the irregularity in the distribution of materials for maritime meteorology, due to the variety of ships' tracks over the different oceans, it is impossible to lay down general rules on this question."

Prof. Mohn reported as follows on Climatological Tables: The data which we want for determining the climate of a country are steadily increasing. We must from time to time improve and extend our climatological tables and calculate them by the most exact methods. For some countries we have not yet such tables, though the material for them is ready. In climatological work we want always to know the climate of the adjacent countries. Prof. Mohn proposed the following resolution, which was unanimously adopted: "The Conference begs the directors of meteorological systems of all countries to publish from time to time climatological tables for their country, calculated by the best possible methods for as many stations as possible."

The question of Mr. Symons, as to Double Stations, according to Local and International Systems, was referred to a future Conference, with a request for more details regarding the proposition.

Mr. Wragge gave an account of the progress of meteorology in Australia, and especially in Queensland; the progress already made and the results which he had obtained from his weather bureau, established in 1887, had encouraged him to ask if it would not be possible to establish more stations in the South Pacific Islands, in order to obtain data for the study of cyclones, etc., in those regions. Mr. Scott was disposed to recognize the importance of such insular stations, but stated that the Meteorological Office could not subsidize them, although it had within the last three years issued instruments to insular stations in various parts of the world. Dr. Neumayer said that Germany also had established a number of such insular stations in Labrador, on the African coast, in New Guinea, etc. On the proposal of MM. Hann and Mascart, the following resolution was adopted: "The Conference has heard with the greatest interest the account which has just been given of the development of the meteorological service in Australia, and expresses its conviction that an increase in the number of stations in the Pacific Ocean would be of great practical and scientific importance."

IV. WEATHER TELEGRAPHY.

The most important requirements on this subject, as stated by Dr. Neumayer, are the following:

A. Improvements in the existing system of stations in Europe; more rapid transmission of telegrams; further development of the telegraphic service at night time, possibly by utilizing the lines which are at liberty at those hours; extension of the system to the Southwest (the Spanish Peninsula and Madeira) and to the Southeast.

B. The obtaining of recent information from North America and the Atlantic Ocean by means of (1) telegrams from Washington; (2) telegrams from the North Atlantic, to be obtained from fast steamers on their arrival at a port in Europe; (3) telegrams from Newfoundland, as suggested by the Maritime Congress at Washington.

C. The great project of Captain Hoffmeyer to connect telegraphically the Faroe Islands, Iceland, Greenland and Labrador with Europe.

M. Teisserenc de Bort, reporting on section A, said: The improvement of weather forecasting is recognized to be a matter of very great importance, and this is governed in a great measure, independently of the advance of our scientific knowledge by the rapidity with which information reaches us. There is, therefore, a general desire that the rate of transmission of weather reports should be accelerated, especially in some countries where the transmission is at present so slow that the reports do not arrive until after the forecasts for the day have been issued. It is therefore necessary that the directors of meteorological services should endeavor to secure improvement in this particular in their respective countries, and in this sense the resolution has been proposed. M. Arcimis explained that great difficulties existed in the way of improvement of telegraphic reports in the Spanish Peninsula. Prof. Wild proposed to add to the resolution the extension of telegraphic reports in the southeast of Europe, particularly in the Balkan Peninsula, and the resolution was adopted in the following form: "The Conference declares that it is very important to accelerate the transmission of the reports from the Iberian Peninsula and from Madeira, and it requests the directors of the services of these countries to use their best efforts to the attainment of this object, which is of great importance, and at the same time expresses the hope that the system of telegraphic weather reports should be extended to the Southeast, especially over the Balkan Peninsula." M. Watzoff announced that the Bulgarian governmen was ready to carry out the wishes of the Conference as soon as possible.

On section B, M. Teisserenc de Bort reported that in his opinion it would be premature to propose any resolution. Only France received telegraphic reports and the question was still in the condition of a scientific investigation. Mr. Scott spoke against the proposal B. He said the London Meteorological Office had for several years received dispatches from Washington, in part by the kindness of the French Meteorological Office, but it had come to the conviction that the dispatches were not worth the money they cost. The great difficulty in using them came from an insufficient knowledge of the probable tracks of the depressions announced from America, and of their rate of motion. In the course of the thirteen months, August, 1882, to August, 1883, inclusive, twelve severe storms had reached the British

Isles, which, according to his own investigation, had been more or less proved to have come from the area of the Signal Office system. The interval which these had respectively taken to cross the ocean were as follows: Four took two days, three took three days, one took four days, one took five days, two took six days, and one took ten days. M. Teisserenc de Bort was of opinion that it was always desirable to know in general what condition existed to the westward, and that from this point of view there was a real value in the telegrams from America. Prof. Wild indorsed the last statement. M. Snellen was of opinion that our judgment would be clearer if we heard nothing of a disturbance in the west, which possibly might not reach us. The late Prof. Buys-Ballot had published, prior to 1884, a statistical study of the *New York Herald* warnings, in which it was shown that these reports were of little value, as but few of the disturbances which were announced crossed the Atlantic to Europe. M. Mascart reminded the Conference that the proposal for these messages had been generally approved by the Paris meeting. At the same time they were very costly, and at present were only received in France. M. Mascart thought that the present state of affairs should be maintained in order to afford a firm basis of procedure in case at any future time it should be found possible to extend the system of trans-Atlantic telegrams. He urged that in the discussion of such a question it is not only the practical utility but also the great encouragement to scientific inquiry which should be kept in view. Mr. Scott said that mid-Atlantic stations had often been suggested, that is, reports from ships anchored at a distance of 300 or 400 miles from the coast of Ireland. He could prove to the Conference the impracticability of carrying out the suggestion, owing to the very great cost. The possibility of maintaining telegraphic connection with a ship at anchor for a whole year had been proved, but the cost of laying a cable 200 miles would be $350,000, and to that we should have to add the cost of the ship, etc., and the pay of the staff. Gen. Greely urged the importance to European meteorologists of the knowledge of the meteorological conditions over the Atlantic Ocean in making forecasts. He believed that daily reports from the Azores, Bermudas and other islands would be of the utmost importance. Dr. Schreiber thought that it was desirable to obtain information from ships as to weather in the northern part of the Atlantic Ocean, and Dr. Neumayer replied that he

had already endeavored, by the assistance of two German steamship companies, to obtain such reports, and he hoped to extend this system in the approaching winter. Dr. Schreiber's proposal that All Observations over the North Atlantic Ocean be Published as speedily as possible was deemed to be impracticable and was declined, but the following proposal from MM. Wild and Mascart was accepted: "The Conference expresses the wish that reports from North America, the Atlantic Ocean, and from the Azores, as mentioned in section B, should be developed and extended as much as possible."

On section C of the general question, Dr. Neumayer reported as follows: This project appears to be a desideratum of the highest importance to every one who has engaged in weather study. The investigations of Captain Hoffmeyer have materially contributed to the elucidation of this important matter. There is at present little hope of the realization of M. Tietgen's plan, but the importance of a cable connecting Scotland, the Faroe Islands, Iceland, Greenland and Labrador must still be asserted. The cable to the Azores would also be of very high importance. The Conference expressed its assent to Dr. Neumayer's remarks.

In regard to M. Snellen's recommendation on the Rapid Transmission of Telegrams, it was decided that owing to its non-official character the Conference was not in a position to take action in the matter, but the question remains as one to be referred to the future International Committee for its serious attention.

Prof. Wild withdrew his question: Would it not be well to make General Rules for the Verification of Storm Warnings and Forecasts?

The proposition of Dr. Ekholm, of Stockholm, to Alter the Code for Weather Telegrams was discussed at length, and the following resolution of M. Mascart was adopted: "The practical experience of the directors of the different meteorological institutes is opposed to any alteration in the telegraphic reporting code."

Dr. Nemayer, at this juncture, proposed the following resolution, which was adopted: "It is very desirable that a system of meteorological observations in Brazil should be developed and extended, in order thereby to augment our knowledge of the climatological and meteorological condition of South America." Captain Pinheiro, having given to the Conference a detailed account of the meteorological organization of Brazil, Mr.

Scott proposed the following resolution, which was adopted: "The Conference has heard with great interest the account which Captain Pinheiro has given of the development of the meteorological service of Brazil."

Profs. Wild and Harrington offered the following resolution, which was unanimously adopted: "As it appears too late to consider new questions at this Conference, it should therefore be impressed upon the committee which may be appointed, to consider the subject of the proper method of extending meteorological observations and publications in the interest of agriculture, and that this committee prepare a proposition thereon for the future general congress."

On motion of Dr. Erk, the Conference adopted the following resolution: "The directors of meteorological institutes are requested on the back of the title pages of the volumes of daily weather reports to give for the stations of their own system the following data: Latitude, longitude, altitude of barometer above sea-level, altitude of thermometers and rain-gauge, respectively, above ground." In justification of the proposal, Dr. Erk alluded to the difficulty of obtaining these facts, and the great importance of a knowledge of them.

Dr. Eschenhagen, as secretary, read the resolutions of the Magnetic Committee, consisting of MM. von Bezold, Biese, Abbe, Eschenhagen (secretary), Greely, Hergesell, Hepites, von Konkoly, von Oettingen, Mascart, Paulsen, Pinheiro, Lang, Neumayer, Snellen, Schreiber, and Wild (president), which were as follows:

1. The Lloyd balance gives actually, when proper precautions are used, the most reliable results of the variation of the vertical intensity of terrestrial magnetism.

2. The Committee declares itself ready to recommend for magnetic variation instruments the introduction of the scale for the ordinates of the curves proposed by Dr. Wild and adopted by the British Committee, namely: Declination: 1 m.m. = 1′; Horizontal and Vertical Intensity: 1 m.m. = 0.00005 C. G. S. It appears still more important to secure uniformity in the measures of the abscissæ, in order to facilitate the comparison of the curves. The Committee is of the opinion that the copies of the perturbations, which are to be exchanged between the various observatories, should have abscissæ of a uniform length of 15 m.m. per hour, according to a former resolution of the International Polar Conference.

3. The Committee deems it necessary to compare the instruments used for absolute measures at the various observatories and to publish the results.

4. It appears necessary, in the introductions to the publications of the magnetic observations, to give always the absolute values of the normal readings of the variation instruments, as well as other explanations referring to them, but especially the data about the auxilliary and control observations which have served to determine the scale values.

5. As to the minimum amount to be published, the Committee proposes that at least the daily period for each month and year, as well as the annual period from the monthly means, should be deduced. Besides this, it is desirable that some of the interesting disturbances should be reproduced.

6. The question as to the reduction of the magnetic elements to epoch values is referred to a geodetic conference.

7. The Committee is of the opinion that observations of earth currents are of the greatest importance, but it is not in a position to give further instructions for these observations.

8. The Conference, in consequence of the information furnished by MM. Paulsen and Abbe, expresses the wish to the Superintendent of the United States Coast Survey that a permanent magnetic station, provided with registering instruments, should be erected near the meteorological station at Point Barrow.

9. Concerning the methods for the observation of atmospheric electricity, some gentlemen of the Committee have given their views and experience for this report.

The above resolutions were unanimously adopted.

Dr. Billwiller submitted the following resolutions of the Committee for the observation of the direction of motion and the height of the upper clouds, which resolutions were also unanimously adopted. These resolutions follow:

1. The Committee proposes that at the seventeen following stations, namely, Kew, Upsala, Blue Hill, North Cape, Pawlowsk, Catherinenburg, Berlin (Potsdam), Tiflis, Irkutsk, Odessa, Taschkent, Paris, Lyons, Puy de Dôme, Algiers, Antilles and Madagascar, measurements of the direction of motion and the height of clouds shall be commenced not later than May 1, 1894, and continued during a whole year. Besides the above named stations, these stations should also coöperate in the observations: One or two stations in West Africa, one

station at the Cape of Good Hope, one station in the interior of North America, besides stations at Tokio, in Australia and in Chile.

2. Dr. Hildebrandsson is requested to prepare simple instructions for the observations.

3. The responsibility for the carrying out of the resolutions shall be given to a committee chosen by the Conference, or to the permanent international committee about to be chosen.

At the eighth, and last meeting of the Conference, on the afternoon of September 2, Prof. Harrington submitted to the Conference the latest volume (Part IV, Storms) of the Bibliography of Meteorology. He remarked that the present issue of the Bibliography was to be regarded as a printed MS., and requested that omissions and errors in it should be reported to the United States Weather Bureau. Gen. Greely remarked that the form of this issue had been much criticised, but that he had thought it best to let the public know as soon as possible what existed in his office, etc. It was proposed at some future date to publish in better form a complete catalogue. On motion of Dr. Billwiller, the following resolution was adopted by acclamation: "The Conference expresses its warmest thanks to the Chief Signal Officer and to the present Director of the Weather Bureau for the very useful undertaking of the issue of the Bibliography of Meteorology, and combines with this utterance the hope that the complete publication of the work may ultimately be effected."

V. ADMINISTRATION.

Upon the Organization of an International Bureau, Prof. Wild reported: The idea of an International Scientific Institute has already been discussed at Rome, and the serious difficulties to its realization may be learned from the Report of that Congress. On the other hand, Prof. Wild thought that it would be less difficult to create an International Meteorological Bureau for administrative purposes, and therefore proposed this resolution: The Conference is of opinion that it would be very useful on the basis of an international agreement between all countries, to substitute an International Meteorological Bureau, which should be charged with the following duties:

1. The Bureau has to see that the protocols of international conferences, committees or sub-committees should be published in English, French and German, and distributed. At the time

of any meetings of such conferences, this Bureau and its staff shall be at the service of such conference for the supply of information, and for the preparation, etc., of its protocols.

2. During the intervals between these international meetings the Bureau has to maintain a correspondence with the different meteorological institutes and with meteorologists in general. It will be the authoritative channel for the communication of the resolutions of meteorological congresses or conferences to any persons interested therein, and will furthermore prepare a catalogue of all the meteorological publications of different countries and place it at the service of meteorologists.

3. It will assist at the preparations for meteorological conferences and congresses by arranging the programmes and procuring reports on special questions, etc.

4. The Bureau will be under the control of an international staff, and will be maintained at the cost of the participating states.

In order that the Conference should not imagine that it is suggested that these comprehensive ideas should be considered at present, Prof. Wild in conjunction with M. Mascart, proposed the following resolution: Without expressing any opinion on the details of the proposition, the Conference refers the same to the future International Committee. M. Mascart remarked that the existing conference could only deal with the subject in so far as it was purely scientific, and that no person could enter into any promise as to future expenditures, or express any opinions thereon which would be officially binding. MM. Scott, von Bezold and Neumayer thought that the idea of an International Bureau would hardly be entertained by their respective governments. Prof. Hildebrandsson also said that it would be very difficult to carry out the scheme, even if the Conference was of the opinion that such an institution would be useful. In that case the question might be referred to an International Committee. Dr. Billwiller remarked that it should first be decided whether the proposal would be productive of so much good that it could be brought before the notice of the governments, but it was doubtful if any committee would have the right to enter on the discussion of such a subject.

By general consent the question was restricted to that of the Establishment of an International Committee. Prof. Wild proposed that an International Committee should be created of a similar character to that appointed by the Congress of Rome,

but, acting on a suggestion of M. Mascart, put his proposal in this definite form: An International Committee is to be established to deal with the following matters and questions:

1. The issue of the protocols in three languages.
2. The question of the establishment of an International Bureau.
3. The subject of agricultural meteorology.
4. The establishment of stations for observing the motion of the upper clouds.
5. M. Snellen's question as to the acceleration of telegrams.
6. The organization of the next congress.

The committee is to consist of seventeen members, representing different countries; of these fourteen are to be elected by the Conference by ballot, while the three remaining places are to be filled by the Committee itself by co-option. In the case of any vacancy, caused by resignation or death, the Committee can complete itself. The Committee appoints its own officers and distributes the work among its members. A discussion of the proposition followed, and, on putting the question, the Conference decided, almost unanimously, that "An International Committee is to be appointed." Prof. Wild voted against the proposition, and Mr. Scott did not vote. The majority of the Conference decided that "The Committee should consist of seventeen members, and that fourteen of them should be elected at once." Prof. Hildebrandsson was of the opinion that no regard should be had to the representation of countries or meteorological services, but simply individuals should be selected who were in the position of being able to carry out the duties intrusted to them. Prof. von Bezold proposed to elect by acclamation the members of the late International Committee as members of the new Committee. Dr. Neumayer requested permission to resign his seat on the Committee in consequence of his numerous engagements, and at the same time thanked the Conference heartily for its expression of continued confidence in him. These other members of the late International Committee were then elected by acclamation: Vice-admiral de Brito Capello, Prof. Dr. Hann, M. Mascart, Prof. Mohn, Mr. Scott, Prof. Tacchini, Prof. Wild. It was arranged to select seven additional members by ballot. Before proceeding further, Dr. Erk asked to be excused from voting, in order that one country (Bavaria) should not exercise two votes; similarly, Dr. Eschenhagen (Prussia), Harrington, Greely and Abbe (United States),

abstained. Dr. von Oettingen did not vote, and MM. Hepites and Neumayer left before the ballots were cast. Their count resulted as follows: Von Bezold twenty votes, Harrington twenty, Hildebrandsson nineteen, Billwiller seventeen, Snellen seventeen, Arcimis, fourteen, Hepites twelve, Lang seven, Paulsen six, Wragge four, Greely, Pinheiro, Teisserenc de Bort and Rotch three each, Schreiber two, Abbe and von Oettingen one each. M. Arcimis requested permission to decline the honor conferred upon him. Accordingly the seven additional members of the Committee are: Prof. Dr. von Bezold, Dr. Billwiller, Prof. Harrington, M. Hepites, Prof. Dr. Hildebrandsson, Dr. Lang and M. Snellen. The Committee at once appointed its officers by unanimously requesting Prof. Wild to continue as President, and Mr. Scott as Secretary. Both gentlemen expressed their readiness to serve, provided no objection was raised by their respective superior authorities. The proposed definition of duties for the Committee was then accepted unanimously.

It was moved that in 1896 a new congress should be convened, and M. Mascart was asked if, in his opinion, Paris might be named as the locality for that meeting. M. Mascart said that he had learned from Prof. Harrington that in 1893 a free general congress of meteorologists from all parts of the world would take place at Chicago, and that it was very desirable that as many representatives of the Old World as was possible should attend it. As to the proposed congress in Paris, if that was to have an official character he could give no binding reply to the question which had been put him, but he thought that a non-official congress would certainly meet with all the encouragement which could be desired. The Conference decided by a majority of votes that "A Congress should be held in Paris in the space of five years, and remitted the question of its official or non-official character to the Committee." This completed the entire programme for the meeting.

General Greely, in the name of the foreign members, and especially of the Americans, expressed the warm thanks of the meeting to the Bavarian authorities, for the reception which they had accorded to it, and Messrs. Pinheiro and Wragge spoke in the same sense. Dr. Lang thanked the Committee for the honor conferred upon himself, and especially Messrs. Wild and Scott for their assistance in the arrangement of business, and to the secretaries for all the trouble they had taken. The session and the Conference were then declared closed.

THE METEOROLOGICAL STATION OF NAHA, LIUKIU ISLANDS, JAPAN.

By Y. Wada.
Of the Tokio Central Meteorological Observatory.

The only continuous meteorological observations which had been made on the Liukiu Islands up to last year were those of Fr. Furet, published in the *Zeitschrift der Oesl. Gesel. für Meteorologie, Bd. VII*, and in the *Comptes-rendus de l'Académie des Sciences de Paris, Vol. LXVIII.* They include a period of one year and ten months, from December, 1856, to September, 1858. It is true that there are other more recent ones, but most of them were only temporary observations, maintained during a short period, by war ships or merchantmen.

In the year 1890 the prefect of Okinawa, (the Liukiu Islands being governed by the pref-cture of Okinawa, situated at Naha,) desiring to establish a meteorological station, asked for the necessary sum to purchase instruments and to pay the observer, which the Minister of the Interior, recognizing the importance of the station with respect to agriculture, hygiene and navigation, granted, and M. Kageyama, an experienced observer, employed up to that time in the Tokio Observatory, was appointed to take charge of the observations. Thus, preparations having been completed, the first regular observations were commenced July 1.

The meteorological station of Naha (longitude east from Greenwich 127° 41′; north latitude 26° 13′, altitude 46 feet) is of the second order, and possesses a mercurial barometer, an aneroid barometer, a standard thermometer, a psychrometer, an anemometer, a wind-vane, and a rain-gauge, all verified at the Central Observatory. The hours of observation are, as for all the Japanese second-order stations, 2, 6 and 10 A. M., and 2, 6 and 10 P. M., and the means are computed from these six daily observations.

This station is very favorably situated to study the typhoons of the China and Japan Seas, of which a great number pass near the station, and as soon as the island is connected to Kiushu by a submarine cable, it will be the most important of all the Japanese stations for the warning of storms on these coasts and on the coasts of China, Corea and Siberia.

The principal results obtained at the station of Naha during a whole year, commencing with July, 1890, are as follows:

Mean atmospheric pressure, 29.910 inches.

Maximum atmospheric pressure, 30.31 inches, on February 18 and March 23.

Minimum atmospheric pressure, 29.21 inches, on September 21.

Mean air temperature in the shelter, 71.1° F.

Maximum air temperature 93.9° F., on July 3.

Minimum air temperature 45.3° F., on January 21.

Mean variation of the extreme temperatures, 11.5°.

Maximum variation of the extreme temperatures, 48.6°.

Mean relative humidity, 76 per cent.

Total precipitation, 92.19 inches.

Maximum precipitation in twenty-four hours, 13.85 inches, on April 11.

Maximum precipitation in four hours, 6 93 inches, on April 11.

Mean wind velocity, 10.5 miles per hour.

Maximum velocity and direction, 70 miles per hour, N.W., on September 21.

Mean direction of the wind, N. 51° E.

Number of days with precipitation, 200.

Number of days with hail, 1.

Number of days with thunder-storms, 21.

Number of days clear, 14.

Number of days cloudy, 165.

Number of days with strong winds, 90.

Number of days with a mean temperature above 77° F., 111.

THE WIND-RUSH AT WASHINGTON, D. C., ON NOVEMBER 23, 1891.

PROFESSOR H. A. HAZEN.

This violent gale or wind-rush was probably the most destructive that has ever been noted at the capital. Previous to this the three following are on record:

(1) June 27, 1881. This occurred about 8 P. M. and moved from N.N.W. across the city. As investigated at the time its starting point was not far from Iowa Circle and in its path, which was hardly more than 300 feet wide, it blew off roofs and damaged upper stories for more than a mile. The most serious damage was at the Masonic Temple and City Hall. The esti-

mated loss was about $100,000, which, however, was slightly in excess.

(2) February 15, 1886. A violent and narrow gale blew off the roof of Cissell's flouring mill in Georgetown and also caused some damage at Ft. Myer. At the latter point the gale attained seventy-two miles at 4 P. M.

(3) September 16, 1888. A wind-rush, not more than 200 feet wide in its most destructive portion, struck in the S. W. part of the city, and had a path from the W.S.W. across the botanical gardens. The most serious damage occurred in the upper story of a factory about one-fourth mile W.S.W. of the gardens. Some trees were blown over or broken and the sash of the green houses suffered also somewhat. The path was not much over three-fourths mile in length. No marked wind was felt at the Signal Office on G. street, about one mile away.

(4) November 23, 1891. A little after 12:30 on this date a severe wind-rush passed across the city from a south or southwest direction. The most violent blow and that causing the greatest loss was at Metzerott's hall, nearly in the center of the city. It should be noted that the loss was largely due to the unfinished condition of the walls and not to the severity of the gale. One life was lost at this place, that of Mr. White. It was found very difficult to obtain the exact times. The wind at the Weather Bureau Office reached the highest observed in twenty-one years, sixty miles per hour from S.W., the exact time was about 12:33, estimates vary from 12:31 to 12:35. At the gas works, very nearly due south of the Bureau, the man pulling the rope for the 12:30 whistle had just let go, but the foreman said that his clock might have been two or three minutes slow. At Metzerott's twenty-two of the twenty-three men at work had finished lunch and resumed their places; the foreman thought the wall fell six or seven minutes after the whistle at 12:30. The alarm at the police station was turned in at 12:42, the man who turned it in said that it was about three minutes after the disaster, but it is probable that in his trepidation more time may have elapsed. I would put the exact time at 12:38.

RAINFALL.

Perhaps the most remarkable fact in connection with this wind-rush was the distribution of rain. At this office .18 inch fell and .26″ fell at Kendall Grove, three miles east. A friend was driving in a carriage at corner of M. and 2nd streets, S.W.,

when suddenly the whole outfit, including the horse, was blown over as though by a wind from S.S.E. The wind was so violent that he could not get up and three men who started to rescue him did not dare to go out. There was a regular cloud burst at this point, as the water on the street was instantly nearly a foot deep, and the water in the canal close by, which is twenty-five feet wide, rose about eight feet in a few minutes. An examination of a map of the city shows how the gale caused damage in streaks. The direction of the gust was plainly from the S. W. at this office, south at Metzerott's and, probably, S.E. farther east.

LIGHTNING.

It was reported that the gas holder was struck by lightning, but it is said at the gas office that lightning has *never* damaged a gas holder. The foreman thinks that an iron cap of one of the posts weighing perhaps a ton was blown or broken off by the wind, and when this struck the iron roof of the holder it broke through and its edge struck a fire, as from a flint, and fired the gas. It is possible the iron made the hole and the lightning fired the gas. Pretty good evidence of a flash was gained, but it was said that the roar of the elements would have drowned the thunder, which is hardly probable, however. At the corner of 13th and F. it was reported that, after the show window blew in, a ball of lightning came into the room, punctured several holes in panes of glass and scorched some gloves. A diligent search showed the glove scorching was purely imaginary and the holes in the glass to have been formed by pubbles, no sign of fusing being noted. The store was fitted up with electric lights and there is no doubt the ball of lightning was largely a subjective phenomenon which had its rise in the sudden flash of the electricity that occurred in the breaking of the electric light circuit. Marks of scorching on the ceiling where the electric fixture parted are plainly seen, but they are nowhere else.

One of the more singular freaks or accidents occurred at Byrn's shoe store, very near the corner of 14th and Corcoran streets, facing east. In the back part of the store is a closet or very small room 6′ x 7′, perhaps, in which the cobbler works. The roof of this addition juts into a sort of alley and is only about eight feet above ground. The walls of the houses on Corcoran street rise above this roof forty feet, and form a close wall for 150 feet to the west. A chimney, nearly fifteen feet tall and

situated on the second story, fifteen feet south of the low roof, was blown north and deposited its three cart loads of bricks on the roof over the cobbler. The latter had a very narrow escape from instant death and got off with only a bruise, as one of the roof rafters struck the wall and protected him. But the falling roof seems to have acted like a piston in its descent, for the air forced out two windows in the front of the store, and hence facing east, or the direction of the current which blew out the windows, must have been at right angles to the wind. These windows were one behind the other and the other pair situated exactly like the first, with the front door of the store only intervening, were unharmed. The front window on the side walls was of heavy plate glass, but had a crack in it, the other window had a sash with twelve panes. The force of the gust carried a portion of the inside sash and the plate glass out upon the sidewalk. While the wind must have been deflected down by the high wall to the north yet it does not seem possible that its energy could have produced so extraordinary an effect, nor does it seem credible that the piston action of the roof, more or less retarded and dissipated by its irregular fall, could have done so. It may be that the two combined caused the damage.

The barometric oscillation is of great significance as it was so near the center of the wind-rush. I think the nearest automatic register we have had before this was in the Louisville tornado, March 27, 1890, where the distance was not far from 7,000 feet. In this case we may consider it 5,000 feet.

The curve showing the oscillation will be found in the *Monthly Weather Review* for November. The following description is given here: There was a steady fall in pressure at the rate of nearly .1″ per hour for several hours, when suddenly, at 12:30, the pressure began to rise and continued till it had risen nearly .1″ in five minutes, or twelve times as fast as it had fallen previously, after which it fell about .05″ rapidly, and then continued nearly horizontal.

It is highly probable that seventy-five per cent., if not ninety per cent., of the so-called tornadoes or cyclones of the western states are in every essential particular like this wind-rush at Washington, D. C. The houses and barns of the western prairies are more exposed to the action of the wind and, in most cases, are not as substantially built as in the east. The most serious loss was in an insecure building and the total loss, it should be borne in mind, was generally to roofs and not to walls.

The loss of property, including $70,000 at the gas holder, has been estimated from $150,000 to $200,000, perhaps $200,000 is an overestimate.

The severe local gusts extended from North Carolina to New York, and had a general progression as to time of occurrence from west to east, though the general movement was from south or southwest, to north or northeast. Several are located near Pittsburg, Pa., at 10:30. The earliest in North Carolina was at 9:00 to the westward, and another to the eastward at 10:30. At Frostburg, in extreme West Maryland, where there was a damage from $30,000 to $40,000, the blow occurred at 11:10. It occurred at Suitland, in Southeast Maryland, at 12:50. At Harrisburg, Pa., the time recorded was 13:30. In Western New York it was at about 14.ʰ00. The latest time reported was 15:15 at Leacock in Eastern Pennsylvania. The direction of motion reported by individual observers was almost invariably from S.W. to N.E. There can be little doubt that there were a very large number of severe local wind-rushes having narrow paths from S.W. to N.E., and these paths gradually moved toward the east.

December 26, 1891.

CURRENT NOTES.

CLIMATOLOGY OF IOWA.—The annual report of the Iowa Weather and Crop Service for 1890 is an octavo of ninety-four pages. In addition to the usual summary of observations, it contains much matter (sixty-one pages, or about two-thirds) concerning the climate and physiography of the State, forming together a compilation which will prove useful to students of American Meteorology. Especial attention is called to the fact that the precipitation is mainly a spring and summer one—making the state a better agricultural one than others with a larger rainfall not so well distributed through the year. Vigorous protest is also entered against the idea that tornadoes or other destructive storms are unusually frequent, or severe, in this state. J. R. Sage, director of the service, and Dr. Geo. M. Chappel, of the Weather Bureau, are the editors.

THE ROMAN EXPLOSION AND THE BAROMETER.—In a recent number of the *Annuaire* of the French Meteorological Society, quoted from the journal *Cosmos*, is given the result on the auto-

matic barometers of the heavy powder explosion near Rome, last May. The observatory of the Roman College was four kilometres distant; the barometers there showed the following undulations: An augmentation of pressure of 11.4 millimetres, then a diminutive of 20.2, then a second oscillation of + 11.7 and — 4.4 millimetres, then an increase of 1.5 millimetres, with which the oscillations ended.

At Monte-Cava, twenty-two kilometres from Rome, the oscillation was +1.7 and —1.3 millimetres. The sound was simultaneous with the wave. The terrestrial waves preceded the ærial and seemed to have a velocity of 680 metres per second, or about twice that of sound.

Publications of the English Meteorological Office.— The first of the two publications received lately is a bound collection of the meteorological charts for six weeks, to give the history of the celebrated storm which crossed the Arabian sea and destroyed the German corvette "Augusta," and the French despatch boat "Rénard," at Aden, on June 3, 1885. The charts are very attractive in appearance. There is no comment on them, but the storm has already received much discussion. This and the following bear the date of 1891.

The second is a series of monthly and accessory meteorological charts of the Indian ocean, adjacent to Cape Guardafui. They contain the winds and the temperatures of the sea. The latter is the interesting feature as, because of the difficulties of navigation in the vicinity of this cape, it was desirable to give captains additional tests of latitude, and it was generally believed that a temperature of 80° F. was never found south of the cape. This would permit captains to feel their way with the thermometer, very much as they do off the New Jersey coast with the lead, but these charts show that this criterion is not a safe one. The charts are unattractive and confusing, but the careful study which navigators will give them will doubtless make them useful in the way intended.

Balloon Meteorology.—At the meeting of the Berlin Meteorological Society, on December 1, Dr. Assman spoke on observations during balloon voyages and in captive balloons. For the determination of temperature, humidity, and atmospheric pressure in a free balloon, the aspiration thermometer and aneroid barometer suffice. Comparative measurements

made by Rotch, in Paris and in Berlin, during balloon voyages, showed higher than does a maximum and minimum thermometer, and the latter always shows a temperature 2° C. higher than does an aspiration thermometer. In order to carry out prolonged observations on humidity during a balloon trip, three aspiration thermometers must be combined, of which two are alternately moistened, while the third is kept dry. For use in captive balloons self-registering instruments must be employed, whose construction, owing to the frequent violent vertical jolts of the balloon, presents considerable difficulty. The speaker exhibited tracings which showed that these difficulties had been overcome by him. Temperature is recorded by a bent Bourdon tube filled with alcohol, humidity by a hair hygrometer, and atmospheric pressure by an aneroid; all these instruments being placed in a space in which aspiration is continuously kept up. Each instrument records on a cylinder which rotates once in about five hours. The German Ballooning Society proposes to make simultaneous observations (1) in a free balloon, (2) with self-recording apparatus suspended by a long cable from the car of the balloon, (3) with a second similar apparatus in a captive balloon, and (4) at the earth's surface. By this means simultaneous determinations of temperature, humidity, and pressure at four different air-levels would be obtained.—*Nature*, December 17, 1891.

Royal Meteorological Society.—The usual monthly meeting of this Society was held on Wednesday evening, December 16, at the Institution of Civil Engineers. Mr. Baldwin Latham, M. Inst. C. E., President, in the chair.

Mr. R. A. Hooker, B. A., Mr. A. B. MacDowall, M. A., Mr. E. G. Ravenston, F. R. G. S., and Mr. R. Hedger-Wallace were elected fellows of the Society.

Mr. W. Marriott gave the results of the investigation undertaken by the society into the thunderstorms of 1888 and 1889 which he illustrated by a number of lantern slides. The investigation was originally confined to the southeast of England, but as this district was found to be too circumscribed, it became necessary to include the whole of England and Wales. After describing the arrangements for collecting the observations and the methods adopted for their discussion, Mr. Marriott gave statistics showing the number of days on which thunderstorms occurred at each station; the number of days of thunderstorms

in each month for the whole country; the number of days on which it was reported that damage or accidents from lightning occurred; and also the number of days on which hail accompanied the thunderstorms. In 1888 there were 113 days, and in 1889 123 days on which thunderstorms occurred in some part of the country. The number of days with damage by lightning was thirty-three in 1888 and thirty-eight in 1889; and there were fifty-six days in each year on which hail accompanied the thunderstorms. The tables of hourly frequency show that thunderstorms are most freqnent between noon and 4 P. M., and least frequent between 1 A. M. and 7 A. M. Thunderstorms seem to travel at an average rate of about eighteen miles per hour in ill-defined low barometric pressure systems, but at a higher rate in squally conditions. The author is of opinion that individual thunderstorms do not travel more than about twenty miles; and that they take the path of least resistance, and are consequently most frequent on flat and low ground. Detailed isobaric charts, with isobars for two-hundredths of an inch, were prepared for 9 A. M. and 9 P. M. each day for the month of June, 1888. An examination of these charts showed that instead of the pressure being so very ill-defined, as appeared on the Daily Weather Charts, there are frequently a number of small, but distinct areas of low pressure, or cyclones, with regular wind circulation; and that these small cyclones passed over the districts from which thunderstorms were reported. Sometimes it is not possible to make out well-formed areas of low pressure from two-hundredths of an inch isobars, but there is a deflection of the wind which shows that there is some disturbing cause; and thunderstorms have usually occurred in that immediate neighborhood. The author believes that the thunderstorm formations are small atmospheric whirls—in all respects like ordinary cyclones and that the whirl may vary from one mile to ten miles or more in diameter. There are frequently several whirls near together, or following one another along the same track. The numerous oscillations in the barometric curve are evidently due to the passage of a succession of atmospheric whirls; and it appears that lightning strokes are most frequent when these oscillations are numerous.

Mr. F. J. Brodie read a paper "On the Prevalence of Fog in London During the Twenty Years, 1871 to 1890." The popular notion that November is *par excellence* a month of fog is not

confirmed by the figures given by the author. The number of fogs in that month is, if anything, slightly less than in October or January, and decidedly less than in December, the last mentioned month being certainly the worst of the whole year. The latter part of the winter is not only less foggy than the earlier part, but is clearer than the autumn months. In February the average number of days with fog is only 6.6, as against 8.9 in January, 10.2 in December, 9.2 in October, and 8.8 in November.

EXPLANATION OF THE WEATHER CHART.—Lieut. Glassford has drawn up the following explanation of the weather-map, and this is now issued to the public by the Bureau.

"The Weather Bureau Charts present an outline map of the United States and Canada, upon which are shown the stations where weather observations are taken daily at 8 A. M., and 8 P. M., 75th meridian time, and telegraphed to the principal cities. These observations consist of readings of the barometer, thermometer, direction and velocity of wind, state of sky (whether cloudless or otherwise), and amount of rain or snow fall. These are entered in figures and symbols upon the map. Lines, called isobars, are drawn through or near stations where the barometer readings are the same. A separate one is drawn for each difference of one-tenth of an inch in the height of the barometer. Dotted lines, called isotherms, connecting places of the sametemperature, are drawn for each ten-degrees reading of the thermometer. The direction of the wind at each station is indicated by arrows, the arrows pointing in the direction the winds are blowing, or opposite to the way a vane points.

"The general movement of storms in the United States is from west to east, and we may liken them to a series of rather rounded atmospheric waves of which the crests are marked 'High,' and oval troughs or depressions between are marked and called 'Low.' These alternating Highs and Lows, several hundred miles apart, have an average easterly movement of about 600 miles per day.

"High winds and rain, and, if cold enough, snow, usually precede the low area, often extending to a distance of 600 miles; in advance of the low center the winds are generally southerly, and consequently bring high temperature. When the center of the Low passes to the east of a place the wind at once shifts to the north, which brings lower temperature and clearing skies,

and in winter cold waves or northers. The temperature on a given parallel west of the Low may be reasonably looked for on the same parallel to the east when the Low has passed, and frost will occur along and north of an isotherm of about 40° if the night is clear and there be but little wind. Following the Low comes an area of High, bringing sunshiny weather, which in its turn is followed by another Low.

"By bearing in mind a few general rules as to the direction and rate of movement of the Low and High, with the blowing of the wind from the High toward the Low, coming weather changes may be foreseen by a glance at the map. The centers of Low do not move across isotherms, but follow their general direction.

"The cloud and rain area in front of a Low is about the size of the latter and oval, with the west side touching the center of the Low in advance of which it progresses.

"When the isotherms run nearly east and west, no decided change in temperature will occur. If the isotherms directly west of a place incline from northwest to southeast, it will be warmer; if from northeast to southwest, it will be colder. Southerly winds prevail west of a nearly north and south line cutting the middle of a High, also east of a like line cutting the middle of a Low. Northerly winds occur west of a nearly north and south line passing through the middle of a Low and also east of a similar one through the middle of a High.

"An absence of decided waves of High or troughs of Low pressure indicates a continuance of existing weather which will last till later maps show a change, usually first appearing in the west."

EXPLANATION OF THE FLAG AND WHISTLE SIGNALS ADOPTED BY THE UNITED STATES WEATHER BUREAU.*—1. The Weather Bureau furnishes, when practicable, for the benefit of the general public and those interests dependent to a greater or less extent upon weather conditions, the "Forecasts" which are prepared at this office daily, at 10 A. M. and 10 P. M., for the following day. These weather forecasts are telegraphed to observers at stations of the Weather Bureau, railway officials, and many others, and are so worded as to be readily communicated to the public by means of flags or steam whistles. The

* Copy of the Official Circular.

flags adopted for this purpose are five in number, and of the form and dimensions indicated below:

EXPLANATION OF FLAG SIGNALS.

Number 1, white flag, six feet square, indicates clear or fair weather. Number 2, blue flag, six feet square, indicates rain or snow. Number 3, white and blue flag (parallel bars of white and blue), six feet square, indicates that local rains or showers will occur, and that the rainfall will not be general. Number 4, black triangular flag, four feet at the base and six feet in length; always refers to temperature; when placed above numbers 1, 2, or 3 it indicates warmer weather; when placed below numbers 1, 2, or 3 it indicates colder weather; when not displayed, the indications are that the temperature will remain stationary, or that the change in temperature will not vary more than four degrees from the temperature of the same hour of the preceding day from March to October, inclusive, and not more than six degrees for the remaining months of the year. Number 5, white flag, six feet square, with black square in centre, indicates the approach of a *sudden* and *decided* fall in temperature. This signal is not to be displayed unless it is expected that the temperature will fall to forty-two degrees, or lower, and is usually ordered at least twenty-four hours in advance of the cold wave. When number 5 is displayed, number 4 is always omitted.

2. When displayed on poles the signals should be arranged to read downward; when displayed from horizontal supports a small streamer should be attached to indicate the point from which the signals are to be read.

INTERPRETATION OF DISPLAYS.

No. 1, alone, indicates fair weather, stationary temperature.

No. 2, alone, indicates rain or snow, stationary temperature.

No. 3, alone, indicates local rain, stationary temperature.

No. 1, with No. 4 above it, indicates fair weather, warmer.

No. 1, with No. 4 below it, indicates fair weather, colder.

No. 2, with No. 4 above it, indicates warmer weather, rain or snow.

No. 2, with No. 4 below it, indicates colder weather, rain or snow.

No. 3, with No. 4 above it, indicates warmer weather with local rains.

No. 3, with No. 4 below it, indicates colder weather with local rains.

No. 1, with No. 5 above it, indicates fair weather, cold wave.

No. 2, with No. 5 above it, indicates wet weather, cold wave.

EXPLANATION OF WHISTLE SIGNALS.

3. NOTE.--The warning signal, to attract attention, will be a long blast of from fifteen to twenty seconds duration. After this warning signal has been sounded, long blasts (of from four to six seconds duration) refer to weather, and short blasts (of from one to three seconds duration) refer to temperature; those for weather to be sounded first.

Blasts.	Indicate.
One long	Fair weather.
Two long	Rain or snow.
Three long	Local rains.
One short	Lower temperature.
Two short	Higher temperature.
Three short	Cold wave.

INTERPRETATION OF COMBINATION BLASTS.

One long, alone	Fair weather, stationary temperature.
Two long, alone	Rain or snow, stationary temperature.
One long and one short	Fair weather, lower temperature.
Two long and two short	Rain or snow, higher temperature.
One long and three short	Fair weather, cold wave.
Three long and two short	Local rains, higher temperature.

(By repeating each combination a few times, with an interval of ten seconds between, possibilities of error in reading the forecasts will be avoided, such as may arise from variable winds, or failure to hear the warning signal.)

4. As the weather forecasts are telegraphed daily to a large number of stations of the Weather Bureau, to railroads, etc., in various sections of the country, there are many small towns which may obtain them by telephone, free of expense; they may also be obtained from the Associated Press dispatches published in daily newspapers. Those desiring to display or sound the signals, and who are not able to obtain the forecasts as above, should communicate direct with the Director of the State Weather Service, or with this office, when, if practicable, the predictions will be telegraphed to them at the expense of the Weather Bureau; and if it is impracticable for the United

States to bear the expense of transmission, they will be furnished at the regular commercial rates and sent "collect."

5. In no case will both A. M. and P. M. forecasts be sent to the same address at Government expense; nor will the telegrams be sent to more than one person, or firm, in any one place, except at the expense of the applicant.

6. Flag weather signals are displayed at many stations throughout the United States, and this improved system has been adopted with the view of securing uniformity, and is recommended after a careful test. The method is not complicated; the solid colors insure legibility, and the flags may be obtained at small expense, or, if desired, material may be procured and the symbols be of home manufacture, no restriction being placed upon the size of the flags, so long as they conform to the system above outlined, but no flags should be less than six feet square.

7. The system of whistle signals may be utilized to better advantage in many places where flags could not be seen at long distances, due notification having been given to the surrounding community through the press and otherwise that, at a designated hour, the steam whistle at a certain place will sound the signal to indicate the probable weather and temperature for the ensuing twenty-four hours.

8. The flag displays here outlined may be greatly extended and become one of the most valuable aids to farmers, shippers, and the public generally, by a little exertion and a small outlay for flags on the part of those who would be benefitted. The system has been adopted and is in use by some of the principal railroads throughout the country, the symbols, made of tin or sheet iron, being displayed from the baggage cars. These roads transmit over their wires each morning, to points from which trains start, the names of the symbols to be displayed, the baggage-master at those points attaching them. When the symbols are displayed on the cars they should be placed one above the other, and read downward. Many large firms and corporations are exhibiting the flags, and at the same advertising their business by printing the signals and their meanings on the back of their business cards.

9. There being but a limited appropriation at the disposition of the Chief of the Weather Bureau for the purchase of flags, it is necessary that the utmost care be used in their distribution in order that they may be placed in proper hands where they will

be properly cared for as Government property and used only for the purpose for which they are intended. In many instances individuals, or firms, receiving the forecasts at Government expense manufacture or procure their own signals for such displays; those desiring to take such action in their individual cases may purchase the flags from any of the following firms at various prices, dependent upon the quality of material used in their construction:

H. Channon Co., Nos. 22, 24, and 26 Market Street, Chicago, Ill.

Crane Cahoone-Barnet Co., McWhorter and Oliver Streets, Newark, N. J.

M. C. Copeland & Co., No. 409 Eleventh Street, N. W., Washington, D. C.

C. S. Decker, No. 168 State Street, Boston, Mass.

Degraw, Aymar & Co., No. 34 South Street, New York City.

S. Hemmenway & Son, No. 60 South Street, New York City.

Horstman Bros. & Co., Fifth and Cherry Streets, Philadelphia, Pa.

John F. McHugh, No. 1263 Broadway, New York City.

Charles Rippe, No. 19 South Fourth Street, Saint Louis, Mo.

Roberts Bros., Nos. 71 and 73 Market Street, Chicago, Ill.

John A. Young, No. 218 Light Street Wharf, Baltimore, Md.

10. Correspondence in relation to the purchase of these flags should be had direct with the above named firms, and not through this office.

11. Communications with reference to the display or sounding of these signals should be addressed to the Director of the State Service in which the station is located or to the Chief of the Weather Bureau, Washington, D. C.

The several States, with headquarters, in which State Weather Services are in operation are as follows:

Auburn, Alabama; Little Rock, Arkansas; Sacramento, California; Denver, Colorado; Atlanta, Georgia; Springfield, Illinois; Indianapolis or Lafayette, Indiana; Des Moines, Iowa; Topeka, Kansas; Louisville, Kentucky; New Orleans, Louisiana; Baltimore, Maryland; Cambridge, Massachusetts; Lansing, Michigan; Minneapolis, Minnesota; University, Mississippi; Columbia, Missouri; Crete, Nebraska; Carson City, Nevada; New Brunswick, New Jersey; Santa Fé, New Mexico; Ithaca, New York; Raleigh, North Carolina; Bismarck, North Dakota; Columbus, Ohio; Portland or Oswego, Oregon; Philadelphia

Pennsylvania; Columbia, South Carolina; Huron, South Dakota; Nashville, Tennessee; Galveston, Texas; Lynchburgh, Virginia; Olympia, Washington; Parkersburgh, West Virginia; Milwaukee, Wisconsin.

WORK OF PROFESSOR HOFFMAN, OF GIESSEN.—This eminent student of the phenology of plants died in Giessen, on October 26, 1891. We take the following account of his work from an appreciative article in the December number of *Das Wetter:*

Geheimer Hofrath, Dr. Hermann Hoffmann, was Professor of Botany, to which post he was appointed in 1873, when thirty-four years of age, and this place he held continuously until the time of his death. He began his phenological studies more than forty years ago. He then began regular phenological observations, which he continued without interruption to the time of his death. Giessen has, consequently, better material for the study of climates and plant life than any other place. They are, for the most part, published in the *Berichte der Oberhessischen Gesellschaft für Natur und Heilkunde zu Giessen.* He also endeavored to have similar observations taken in other places with so good result that, since 1879, they have been taken at about fifty stations, published also in the Upperhessian Society Reports. These were taken under his own instructions, on a short list of plants whose vegetative phases were well marked. Farther, the list of plants was not given in alphabetical order, as were those of Quetelet and Fritsch, but were arranged chronologically—a feature of much more value than would appear on the surface.

These observations Hoffmann endeavored to work up himself. With his own observations he sought to learn the chemical constituents of plant life—a problem which has received the attention of many students since the time of Boussingault. He, however, pursued a new method, to which his name has been given. He made his thermal constant by summing up the maxima of a thermometer placed in the sun's rays, and he sought to prove that a definite phase of the life of every plant of a given species, in a given locality, was reached when a certain sum—the so-called thermal constant for that species and phase—was reached. The plant can thus be considered as a measurer of temperature, or, rather, of the accumulation of temperatures, and there is a quantitive relation between the sun's rays and plant development. He did not, however, believe

that the values which he found for Giessen were absolute, or were the same for other localities, and he left their more exact determination to the future.

The phenological observations at all stations were used by him for comparison among themselves, and thus became a contribution to Climatology. All places were reduced to Giessen, and the results were given in the days of acceleration or retardation over this place. To his comprehensive studies in this direction belongs the comparative phenological chart of Central Europe (*Petermann's Geogr. Mitth.*, 1881), the first phenological chart which has ever appeared. The Vernal Chart of Europe followed this in 1885, in his "Resultate der wicht. pflanzenphänol Beobachtungen." In both charts is given the reduction of the time of flowering to that at Giessen for plants the appearance of whose flowers marks the beginning of spring. These were followed by charts for a number of species which appeared in his "Phänologische Studien," published from 1885 to 1887, in different journals. This comprehensive treatment of the entire phenological material threw much light on problems of Climatology, as well as those of the Geography of Plants and of Biology.

Hoffmann's study of *Quercus pedunculata* and *Sessiliflora* was of especial interest. He found that the former, called in German the summer-oak, reached higher latitudes than the latter, called winter-oak, while the latter climbed higher up on the mountains than did the former. The cause of this he found in the following facts: The summer-oak is more sensitive to heat; it re-acts quickly and develops more rapidly than the winter-oak. It spreads, therefore, northward where summer comes on more suddenly, is more continuous and warmer than on the mountain slopes. A higher sum of temperatures is reached for the same dates than on the mountain slopes. The winter-oak, on the other hand, is less sensitive to heat, and develops more slowly with the same increments of temperature, but, as it passes through its annual phases in a shorter time, the cooler, and hence physiologically shorter, though by the calendar longer, summer of the mountain slopes suffices for it. It requires a lower but develops with a more gradual, cumulation of temperature than the summer-oak.

Hoffmann endeavored to find an application of phenology, even in weather forecast, in that he found a relation between the earlier or later appearance of certain phases of vegetation,

and the mild or severe character of the following winter. It appeared to him (*Meteorol. Zeitschrift*, 1887), that the early ripening of the horse-chestnut indicates a mild winter. Farther investigation, however, showed that this prognosis was not of practical value, because a meteorologically mild winter does not always appear the same to the public.

At the present time there are many places in Germany which serve as centers for phenological observations. Meteorology and Geography both recognize the observations as of value, and Forestry has inscribed phenological observations in its scheme of work. This is largely due to Hoffman, who won new recruits to Phenology by the genuine value of his labors, and greatly enlarged the field of his chosen branch of science. In Hoffmann's death Phenology loses its most eminent and successful student.

CLIMATE AND THE SUGAR BEET.—Sugar cane can be grown only in tropical climates, sorghum cane only in warm regions, but the sugar beet is adapted to cold climates, like those of the higher altitudes in Wyoming. Throughout the farming parts of this State the mean temperature for the growing months ranges from 55 to 65° F. Irrigation eliminates the factor of rainfall. The best sugar producing districts of Europe have a mean summer temperature of about 60°. On the colder side of these districts the sugar harvest is lessened by the greatly increased rainfall in August and September, which prevents the ripening of the beet. On the warmer side a mean summer temperature of above 70° greatly reduces the yield of sugar.* A wet autumn is the greatest disaster that can befall the beet sugar industry. Even Siberia has a successful beet sugar factory.—*Wyoming Exp. Station, Bulletin 3.*

BIBLIOGRAPHICAL NOTICES.

METEOROLOGICAL FOLK LITERATURE.†—In the above Dr. Hellmann presents a carefully prepared and most valuable contribution to the history of a class of meteorological literature,

* Wiley, H. W. *The Sugar Beet Industry*, 1890, p. 169. U. S. Department of Agriculture, Washington, D. C.

† Meteorologische Volksbücher. Ein Beitrag zur Geschichte der meteorologie und zur Kultur-geschichte. By Prof. Dr. G. Hellman. Roy. 8vo, Berlin, 1891. 53 pp (Extract from: Himmel und Erde, Berlin, iii, 1891.)

which has exerted a vast influence among the people, and unfortunately still maintains a strong hold upon them—the popular literature, or folk literature of the weather, which made its appearance in great quantities from the sixteenth to the eighteenth centuries in Europe, and particularly in Germany.

While not neglecting mention of the more important popular books appearing in foreign lands, the paper is devoted primarily to tracing the origin, development, and effect upon the people of this highly interesting class of weather literature in Germany.

An interesting feature of the paper is the copious quotation of original quaint texts and fac-simile reproductions of representative title pages.

Only typical examples are considered, and the first to be noted is "The Book of Nature," by Konrad, of Megenberg. This is the oldest natural history in the German language, being written about the year 1350. The book is not original, but only a free translation, with additions, of a Latin manuscript, "Liber de natura rerum," probably written by Thomas Cantimpratensis, of Belgium, a pupil of Albertus Magnus. The book was first printed in 1475, at Augsburg, and before the middle of the century had reached its seventh edition. The meteorological matter is contained in the seventh chapter, "concerning the heavens and the seven planets." It divides the atmosphere into three regions: the upper, nearest the heat (Feuer), is warm and dry, the middle cold, the lower again warmer, because the sunshine is reflected from the earth and the water. . . . In the upper, which is higher than all mountains, a new star is occasionally seen, which has a tuft or a tail (comet); in the middle are seen during the night various kinds of lights (shooting stars, meteors, etc.); in the lower, the ordinary meteorological elements:

"Rain and snow, hail and lightning, and one hears thunder and falling stones with the thunder, and at times one sees that it rains little frogs or little fishes, there too, one sees dew and frost and wild honey fall, one sees also various winds flying in the air, and the rainbow and the lunar and the solar halo, and also at times two suns or three."

Konrad's explanations of storms, whirlwinds and stormwaves, are entertaining; a literal translation is attempted:

"It happens often, that contrary winds meet one another, as the southerly the northerly, or the easterly the westerly, the

stronger then dashes the other to the earth, or into the water, at times violently, so that it overturns ships; but if they are equal in strength, they struggle with one another so fiercely that both fall to the earth and move in a rapid whirl and often grapple with a large stone or a person, or some other heavy object, and carry it up with them into the air. When, however, they fall into the sea, they dash up the sea water and pour it upon the land and destroy people and things."

Konrad's theory of rain shows him to have been a keen observer, and it may yet be read with profit in these days of artificial rain making: "Rain comes from the watery vapour, which the sun's heat has raised up into the middle region of the atmosphere, when, owing to the cold which is there, the vapour is again converted into water, as we see in the vapour which arises from the boiling kettle over the fire; when the vapour touches the cold iron lid of the kettle it is converted into drops of water." . . . He says it is not true "that thunder is a stone, . . . for if thunder were a stone, it would cause wounds upon the persons and animals struck by it, as other stones do. This does not happen, as we see that persons struck by the thunder do not have wounds." . . . "The Book of Nature" is not in the strict sense a "popular book" as is the one next described by Dr. Hellmann—"Elucidarius" or "Lucidarius." The original of this book is unknown; it is referred by some to a manuscript with the title "Elucidarium" written by Honorius Augustodunensis who died about the middle of the twelfth century; a view, however, which Hellmann is not willing to accept. The first German translation of this book appeared about 1470, and the first dated edition in the year 1475, bearing the title, "Elucidarius, von den wunderbaren sachen der welt," Fol. Augspurg, J. Sorg, 1475. At the close of the sixteenth century about twenty editions had already appeared. It its twenty-five chapters it treats "de omnibus rebus et quibusdam aliis," but is mostly theological. Several chapters are devoted to the weather.

Probably as early as the fourteenth century the weather signs and proverbs of antiquity had been collected together into a sort of handbook of weather forecasts. Such a book made its first appearance in print in 1485 and is interesting as being, as Hellmann believes, the first printed book of purely meteorological contents. It bears the title: "Opuscutū repertorii pronosticon in mutationes æris tam via astrologica qz metheorologica uti

sapietes experientia comperientes voluerunt pqz utilissime ordinatū incipit sidere felici è primo prohemiū." Quarto *Venedig* 1485, 45 pp.

This may be regarded as the forerunner of a series of similar writings of the sixteenth century, written mostly in the Latin language, and hence not intended for the people. Its German representative, however, the "weather book" (Wetterbüchlein) which in terse, plain language presents the important rules for foretelling the weather, is a true folk book. It is a small pamphlet of from seven to ten pages and its forecasts are based mostly upon natural signs. The earliest edition known to Hellmann is that of the year 1508.

A class of literature resembling the latter, but differing from it in having its weather forecasts based upon time-honored superstitions rather than upon natural signs, made its appearance about the year 1508. It is confined almost entirely to the German language; the words "Bauern Practica" are usually found upon the title page. The forecasts rest, with some variations, upon the ancient belief that the twelve days and nights from Christmas to Epiphany determine the character of the weather of the following year, each of these days in succession determining the character of the weather for its respective month.

The next class treated by Hellmann—"Practica and Prognostics"—have for their purpose to foretell the weather for one or more special years; in addition they give warning of the occurrence of events of a general character concerning war, pestilence, etc. These were very numerous in the sixteenth century when fully 500 Practica came to light in Germany alone. The first "Prognostics" appeared in the Latin language, although there were German editions before the close of the fifteenth century. They were for the most part products of astrological superstition, to which is added a little experience and much phantasy. The prognostics gradually found place in the calendars of the time as the latter began to be published annually. Finally it is probable that those who prepared prognostics found it to their advantage to prepare forecasts for several years at a time; a practice which formed such a prominent feature of the "Hundred Years' Calendar," which is the last class described by Dr. Hellmann in his interesting paper.

It was an early custom to add astrological forecasts of the weather to the calendars of the Greeks and Romans. In the

history of the calendar literature of the seventeenth and eighteenth centuries, the hundred years' calendar has a conspicuous and important place as an instrument for diffusing the weather knowledge of the time. The hold it had upon the average man is astonishing; it was his constant household prophet and astrologer. He found in it not only the forecast of the weather, but also the lucky and the unlucky days, the best time for sowing or planting, when to cut his hair, etc., in short a complete guide for all his movements.

In 1654, Dr. Mauritius Knauer, of Kulmbach, completed his manuscript copy of a perpetual calendar and gave it the title: "Calendarium Occonomicum Practicum Perpetuum, das ist Beständiger Hauskalender, etc." This is the original of at least two series of calendars usually bearing the title "hundred years' calendar" which were published in great numbers during the eighteenth and nineteenth centuries. It was probably not put into print until 1701, when a Thuringer physician, Christoph V. Hellwig brought out an edition at Erfurt. From this Hellwig edition about forty others appeared, varying greatly in size, from eighty-eight pages to over four hundred pages.

The fundamental idea of the Knauer calendar is that the seven planets of the Ptolemaic system in succession determine the weather, according to the characteristics which have been ascribed to them by the astrologers of old.

The first edition bearing the name of Knauer was issued in 1704, at Culmbach. From this about ninety editions sprung. It has been estimated that up to the present time about two hundred and twenty different editions of the calendar have appeared.

There are few books that have found such an extraordinary circulation. Probably none, with the exception of the Bible and "The Imitation of Christ," of Thomas à Kempis, have survived more editions.

But as the "hundred years'" calendar had its circulation almost entirely among German speaking people, while the former are spreading over the entire globe, we are driven, says Hellmann, in conclusion, to the mournful conviction that the teachings of the calendar are as widely spread in Germany, as those of the Bible.

O. L. F.